# Advait Mehla

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## ▬▬▬▬ Education

2020 –
Present
**Indian Institute of Technology Bombay**, India
**Bachelor of Technology** in **Engineering Physics**, Grade: 8.81/10
Pursuing a **Minor** in **Electrical Engineering**

## ▬▬▬▬ Publications and Conference Proceedings

○ Bala S., Mate S., **Mehla A.** et al., "Prospects of measuring gamma-ray burst polarization with the Daksha mission," J. Astron. Telesc. Instrum. Syst. 9(4) 048002 *(2023)*

○ Bhalerao V., Sawant D., . . . , **Mehla A.** et al. "Science with the Daksha High Energy Transients Mission" (arXiv:2211.12052), Accepted in *Experimental Astronomy* *(2023)*

○ Mate S., Sastry P., **Mehla A.** et al. "Hard X-ray Polarization measurement capability of Daksha", *Astrophysical Polarimetry in the Time-Domain Era*, Politecnico di Milano, Italy *(2022)*

○ **Mehla A.**, Dewangan G., Mate S., Bhalerao V. "All-sky Compton Imaging with the Daksha space mission", *Poster presented at the ASI 2024 Annual Meeting* *(2024)*

## ▬▬▬▬ Research Experience

Nov 2021 –
May 2023
**Measuring the Polarization of Gamma-Ray Bursts with the Daksha mission**
Guides: Prof. Varun Bhalerao (IIT Bombay), Prof. Shriharsh Tendulkar (TIFR Mumbai)

○ Simulated the interactions of high-energy photons with the satellite mass model and detector readout using the GEANT4 toolkit to obtain realistic event files

○ Obtained the background rates due to Cosmic X-ray Background and Earth albedo

○ Developed a processing pipeline to implement Compton polarimetry with pixelated CdZnTe detectors using a $\chi^2$ fitting-based template matching technique

○ Determined the Minimum Detectable Polarization (MDP) of the mission through a novel Monte Carlo sampling method, estimating the detection rate for polarized GRBs

May 2023 –
Sept 2023
**Demonstrating Optimal Nonlinear Control in a Classical Experiment**
Guide: Prof. Rana Adhikari, California Institute of Technology

○ Designed and constructed low-noise analog circuits for temperature readout and pulse-width modulation (PWM) driven heater circuits for the control system

○ Implemented a Raspberry Pi-based controller including data acquisition and actuation systems using a Waveshare AD/DA Board

○ Created numerical models to simulate heat-transfer mechanisms for an insulated mass, and experimentally constrained free parameters

○ Executed PID temperature control of a system and achieved simulated performance

Aug 2023 –
Present
**All-sky Compton Imaging with the Daksha space mission**
Guide: Prof. Gulab Dewangan, Inter-University Centre for Astronomy and Astrophysics

○ Integrated NaI scintillators into the mass model and emulated SiPM readout to generate realistic data with Poissonian timestamps and effects of spatial and energy resolution

○ Implemented a Compton reconstruction algorithm to utilize coincident events between detector pairs and effectively localize sources in the sky and project them with HealPy

## Awards and Achievements

- Among the **top 23** students worldwide to be awarded a fully-funded LIGO-SURF summer internship at the California Institute of Technology *(2023)*
- Awarded the MITACS Globalink Research Award for a summer internship at TRIUMF, Vancouver and the ANU Future Research Talent Award (both declined) *(2023)*
- Bestowed the Undergraduate Research Award by the Department of Physics, IIT Bombay for performing exceptional research *(2023)*
- Awarded a Branch Change to Engineering Physics on the basis of exemplary academic performance *(2021)*
- Ranked **959$^{th}$** nationwide among **1 million** candidates in the JEE Main exam *(2020)*
- Among the **top 450** students nationally selected for Indian National Physics Olympiad (INPhO), the second stage of qualifiers to the International Physics Olympiad *(2019)*
- Awarded the prestigious KVPY Fellowship by the Department of Science and Technology, Government of India twice with nationwide ranks of **466** and **306** *(2018, 2019)*

## Workshops

**December 2022** — **Radio Astronomy Winter School, NCRA-TIFR Pune**
Ten-day offline school consisting of talks and experiments on the fundamentals of radio astronomy

- Attended seminars by renowned experts on topics like radiative processes, techniques and instruments used, observational radio astronomy, cosmology and fast radio bursts
- Recorded observations of HI emissions at different longitudes in the galactic plane with a horn antenna and obtained a rotation curve for the Milky Way using redshifts

**December 2022** — **GEANT4 and its Application to High-Energy Physics & Astrophysics, IUCAA Pune**
Five-day offline workshop on the applications of GEANT4 intended for graduate students

- Attended talks by prominent researchers working on various experiments like CMS, Hyper-K, POLAR, Fermi and AstroSat, learnt about the simulation techniques utilized
- Implemented detector systems like CMS-HGCAL and a scattering polarimeter from scratch during hands-on tutorials and analyzed resulting data using Python and ROOT

## Other Projects

**Spring 2023** — **Studying an Exoplanetary System with GROWTH-India Telescope (Report)**
Guide: Prof. Varun Bhalerao, IIT Bombay (Course: Observational Astrophysics)

- Submitted a proposal to observe a transit of exoplanet WASP-43b around its host star
- Reduced images to compute the relative flux evolution using `Astropy` and `Photutils`
- Fitted the observed transit data to a model using a Markov-Chain Monte Carlo method with the `exoplanet` package and inferred several parameters within $1\sigma$ of actual values

**Autumn 2022** — **Resonant Mass GW Detectors : Instrumentation & Noise Sources (Report)**
Guide: Prof. Archana Pai, IIT Bombay (Course: Gravitational Wave Astronomy & Physics)

- Surveyed literature on the mechanics of resonant bar gravitational wave detectors, noise sources, measurement challenges involved and limitations of the technique
- Analyzed the electro-mechanical oscillator system and its transfer function to understand its advantages for the detection of gravitational waves
- Quantified the minimal detectable energy and noise spectral density of noise sources

**May 2021 – June 2022** — **IIT Bombay Student Satellite Program**
**Communication Subsystem, GLEE Project**

- Designed a prototype PCB ChipSat capable of processing and wirelessly transmitting data from the lunar environment gathered by two sensors interfaced with a microcontroller
- Implemented UART and SPI communication protocols to achieve data transmission

**Instrumentation Subsystem, GLEE Project**

- Scrutinized components for and constructed a multi-stage analog readout circuit for a PIN diode based spectroscope to study solar flares on the lunar surface
- Verified the functioning of the circuit by injecting simulated input signals

Autumn 2023 **Speckle Imaging and Adaptive Optics**

Guide: Prof. Archana Pai, IIT Bombay (Course: Advanced Astrophysics)

- Discussed the method of speckle interferometry using Fourier transforms to obtain the power spectrum of the source, and demonstrated the technique with SOAR HRCam data
- Studied the working of adaptive optics systems and Shack-Hartmannn wavefront sensors
- Discussed key results from each technique, and compared their advantages and limitations

July 2021 - **Simulating Asteroid Belt Dynamics**
Sept 2021 Summer Project, Krittika: The Astronomy Club of IIT Bombay

- Implemented a Monte Carlo simulation to evolve large distributions of asteroids over millions of years to observe the emergence of features like Kirkwood gaps and Trojans
- Optimised simulation times by a factor of 6 to 12 via implementation of parallelized code using high performance computing libraries like OpenMP and CUDA Fortran

Autumn 2022 **Truly Random Number Generator using Chaos**

Guide: Prof. Pradeep Sarin (Course: Microcontroller Lab)

- Designed and built a chaotic Chua circuit tuned to operate in the double scroll region
- Interfaced the circuit with an Arduino and pre-processed the bitstream using the von Neumann whitening algorithm to de-skew them, proved randomness using rigorous tests

Autumn 2021 **Closed Loop Analog LED Controller**

Guide: Prof. Pradeep Sarin (Course: Op-amp Lab)

- Designed a P-Type Controller with a photodiode as input to maintain the intensity of an LED at a constant set-point in the presence of ambient noise
- Debugged and tuned the circuit parameters after implementing it on a breadboard using several operational amplifiers to achieve stable behaviour

## Technical Skills

**Languages** Python, C/C++, Fortran, MATLAB, LaTeX, Embedded C

**Packages** Astropy, HealPy, Photutils, NumPy, Matplotlib, SciPy, SymPy, Pandas, Numba, PyMC

**Others** Git, GEANT4, OpenMP, CUDA, ROOT, LTspice, Photoshop, EAGLE, Arduino IDE

## Positions of Responsibility

June 2022 – **Manager, Krittika: The Astronomy Club of IIT Bombay**
May 2023 Led a team of 15 to organize outreach and research events to propagate astronomy at IITB

- Handled a budget of INR 250k+ utilized to purchase telescopes, imaging equipment and to organize events such as trivia quizzes, visits to observatories for the student body
- Acquired approval for the development of the IIT Bombay Observatory with an initial funding of INR 2 million, currently spearheading the project
- Organized the Krittika Summer Projects – 10 week long mentored research projects in astronomy; received 100+ applications, international participation for the first time
- Hosted regular observing sessions with a reach of 1000+ students and staff members
- Introduced modern techniques like Electronically Assisted Astronomy to the club's arsenal

Spring 2023 **Teaching Assistant, PH 111: Introduction to Classical Physics**

- Responsible for tutoring 40 students, guiding them with coursework & solving doubts
- Ensured smooth conduction of course by acting as a point of contact between students and course instructors; graded assignments, exams and provided feedback to students

Autumn 2023    **Teaching Assistant, PH 435: Microcontroller Lab**

- Responsible for grading and assisting groups of 10+ students during weekly labs
- Advised teams for hardware projects, guided them with debugging and troubleshooting

## Relevant Courses

**Physics**    Observational Astrophysics, Advanced Astrophysics, Gravitational Wave Astronomy
General Relativity, Quantum Mechanics, Classical Mechanics, Statistical Mechanics
Thermal Physics, Electromagnetic Theory, Nuclear & Particle Physics, Photonics

**Math**    Differential Calculus, Integral Calculus, Linear Algebra, Complex Analysis
Ordinary & Partial Differential Equations, Numerical Analysis

**Computing**    Advanced Simulation Techniques in Physics, Image Processing, Machine Learning

**Electronics**    Analog Lab, Op Amp Lab, Digital Electronics Lab, Microcontrollers Lab,
Digital Electronics, Signal Processing

## Extracurricular Activities and Interests

- Captured several images of deep sky objects, the Milky Way and planets along with special astronomical events like comets, eclipses and meteor showers with basic equipment
- Skilled in processing raw data from professional sources like the HST, JWST; awarded NASA APOD for processing an image of the Trifid Nebula in 2022
- Featured multiple times on outreach pages of NASA and ESA for astrophotography
- Awarded a cash prize and an internship offer as sole winner out of 20+ teams in the Astronomy General Championship conducted by Nayam Innovations and Institute Technical Council, IITB
- Attended the 3-day Vijyoshi National Science Camp conducted at IISc Bangalore for facilitating interactions between KVPY Fellows and world-renowned researchers from various fields of science